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PATENT SPECIFICATION (11) 1 574 660

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(21) Application No. 50610/77 (22) Filed 5 Dec. 1977 (19)

(44) Complete Specification published 10 Sept. 1980

(51) INT. CL.³ G02B 5/16

(52) Index at acceptance
G2J G201 G204 GC GEA

(54) OPTICAL COMMUNICATION CABLE

(71) We, STANDARD TELEPHONE AND CABLES LIMITED, a British Company, of 190 Strand, London WC2A 1DU England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to optical fibre cables, and especially to such cables for submarine use.

Where optical fibre cables are used for relatively long distances, repeaters have to be provided at intervals determined by the attenuation of the optical fibres. These repeaters are powered electrically with the power supplied from the terminal via metallic conductors. In designing a cable to meet these requirements, it is essential that the cable when intended for underseas use should have good flexibility and should be resistant to high pressures and to the action of the sea.

An object of the invention is to provide optical fibre cables in which the above requirements are met in an economical manner.

According to the present invention there is provided an optical fibre cable, which includes a centrally-located tubular electrical conductor which has an external sheath and within which there are located one or more optical fibres, wherein the electrical conductor is a tube the wall of which is thick compared with the diameter of the said optical fibre or every one of said optical fibres with its cladding, and wherein the external sheath includes a layer of a dielectric material overlying the tubular conductor and a tubular strength member which overlies the layer of dielectric material.

According to the present invention there is further provided an optical fibre cable which includes a central electrical conductor which is hollow and cylindrical and within which there is located a plurality of optical fibres each within its own sheath, the wall of said conductor being thick compared with the diameter of every one of said optical fibres with its cladding, a dielectric layer which is also cylindrical and which overlies said tubular conductor, a cylindrical strength member of standard type which overlies said dielectric layer, and an outer sheath overlying said strength member.

The cable constructions to be described herein relate to cables in which four optical fibres have to be provided, although clearly the invention is not so limited. In fact, another construction contemplated provides for twelve optical fibres, all located within the tubular conductor.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which Figs. 1 to 6 are cross-sections of various forms of tubular conductor and optical fibre configurations for a cable embodying the invention, Fig. 7 is a cross-section of a preferred cable embodying the invention, and Fig. 8 shows schematically a joint for a cable embodying the invention.

In the arrangement of Fig. 1 we have an unsupported tube 1 of aluminium which is formed up continuously from sheet material, or is extruded from billet. The optical fibres, each with its cladding, are located inside the tube, as shown at 2. This construction may in some cases be difficult to produce in quantity because of the high ratio k of outside diameter to inside diameter needed to protect the fibres.

Hence it may be preferred to use the split tube arrangement of Fig. 2. In both Fig 1 and 2, the sealing in of the fibres can be effected by welded or soldered joint at 3. Fig. 4 shows a tube such as shown in Fig. 1, but sealed as at 3 by a welded or soldered joint.

The k ratio referred to above may be reduced as in the arrangement of Fig. 3, where we have a tube 5 similar to that of Fig. 1 but thinner, within which there is a support member or kingwire of cruciform cross-section, so that it provides four "tunnels" each of which can accommodate one of the optical fibres. This also can be sealed by a welded or soldered joint at 7.

Fig. 5 shows the use of a tube 10 such as that of Fig. 1 within which the fibres are located and which is surrounded by an outer metal, e.g. copper, layer 11, welded or soldered at 12 to provide the seal. This is at present the preferred arrangement.

Fig. 6 is similar to Fig. 5, but using the split tube arrangement of Fig. 2.

Thus with the above arrangements it is possible to provide a signal member package which gives hermetic and hydrostatic protection for the fibres, and this can be done without the need for an internal supporting kingwire. However, as will be seen from Fig. 3, the invention is applicable where an internal kingwire is considered desirable for specialised applications.

We now turn to Fig. 7 which shows a preferred example of a cable which uses the arrangement of Fig. 5, above. This has a split aluminium tube 15 whose internal diameter is 3 mm. and whose outside diameter is 5.4 mm, within which four optical fibres are located. Surrounding this is a copper tube 16 made from copper tape 0.3 mm thick and 18.9 mm wide which is formed over the aluminium tube so as to provide a hermetic seal.

Overlying the copper tube 16 there is a dielectric layer 17 formed by insulant polyethylene whose outside diameter is 12 mm. The strength member 18 consists of a layer of closely adjacent steel wires, with their bedding, and this layer is enclosed by a sheath or serving 19, with bitumen.

This cable has been found to have good handling characteristics, and its weight is not excessive as indicated by the fact that the weight of its core is 0.315 tons per nautical mile.

One of the advantages of having an external strength member is that jointing is facilitated as indicated by the cross-section of a cable joint shown in Fig. 8. Here we see the signal member 20, which includes the optical fibres and the tubular conductor, the dielectric layer 21 and the strength member 22. The signal members are jointed by an electrically conductive ferrule 23, within which there is, as indicated at 24, accommodation for fibre splices. The outer portion of the joint includes a first ferrule 25 into which the ends of the two dielectric layers, and an outer swaged or shrunk-fit ferrule 26. Thus it will be seen that the use of an external strength member facilitates jointing. It will also be appreciated that it simplifies the problem of connecting the cable to a sealed repeater.

WHAT WE CLAIM IS:—

1. An optical fibre cable which includes a centrally-located tubular electrical conductor which has an external sheath and within which there are located one or more optical fibres, wherein the electrical conductor is a tube the wall of which is thick compared with the diameter of the said optical fibre or every one of said optical fibres with its cladding, and wherein the external sheath includes a layer of a dielectric material overlying the tubular conductor and a tubular strength member which overlies the layer of dielectric material.

2. An optical fibre cable as claimed in claim 1, and in which said tubular conductor is a rolled or extruded tube with a slot from its outside to its inside and within which the optical fibre or fibres is or are located.

3. An optical fibre cable as claimed in claim 2, and in which the tube is rendered hermetic by a welded or sealed joint.

4. An optical fibre cable as claimed in claim 1, and in which the tubular conductor is a split tube formed by two portions which are fitted together to enclose the fibre or fibres.

5. An optical fibre cable as claimed in claim 4, and in which the two portions are fixed together by welded or soldered joints to render the tube hermetic.

6. An optical fibre cable as claimed in any one of claims 2 to 5, and in which within the tubular conductor there is a tubular support section with longitudinally extending tunnels for the or each said optical fibre.

7. An optical fibre cable as claimed in any one of claims 2 to 6 and in which the tubular conductor includes a layer of a highly conductive material such as copper on its outer surface, which layer is completely cylindrical so as to hermetically seal the fibres.

8. An optional fibre cable which includes a central electrical conductor which is hollow and cylindrical and within which there is located a plurality of optical fibres each within its own sheath, the wall of said conductor being thick compared with the diameter of every one of said optical fibres with its cladding, a dielectric layer which is also cylindrical and which overlies said tubular conductor, a cylindrical strength member of stranded type which overlies said dielectric layer, and an outer sheath overlying said strength member.

9. An optical fibre cable as claimed in claim 8, and in which said central conductor is a longitudinally split tube of aluminium with a layer of copper tape overlying it.

10. An optical fibre cable as claimed in claim 9, and in which said dielectric is an insulant polyethylene.

11. An optical fibre cable which includes a tubular electrical conductor formed by a longitudinally-split aluminium tube surrounded by a cylindrical layer of copper tape, four optical fibres each with its own cladding located within said tubular conduc-

tor so as to be hermetically sealed, a layer of polyethylene overlying said tubular conductor, a cylindrical strength member formed by closely adjacent steel wires overlying said polyethylene layer, and a sheath which overlies the strength member, and wherein the wall of the aluminium tube is thick compared with the diameter of every one of said optical fibres with its cladding.

12. An optical fibre cable as claimed in claim 1 having a core substantially as described with reference to any one of Figs. 1 to 6 of the accompanying drawings.

13. An optical fibre cable substantially as described with reference to Fig. 7 of the accompanying drawings.

14. An optical fibre cable joint substantially as described with reference to Fig. 8 of the accompanying drawings.

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Chartered Patent Agent,
For the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

ERRATUM

SPECIFICATION NO 1574660

Page 1, *below* heading (52) Index at acceptance
insert (72) Inventors COLIN STANLEY PARFREE and
PETER WORTHINGTON

THE PATENT OFFICE
26 June 1981

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Sheet 1

Fig.1.

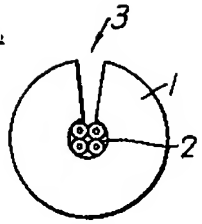


Fig.2.

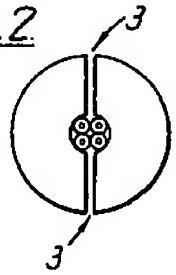


Fig.3.

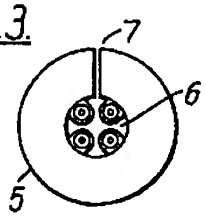


Fig.4.

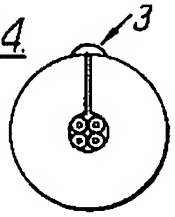


Fig.5.

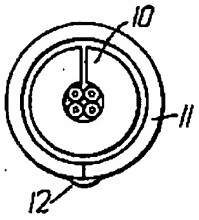


Fig.6.

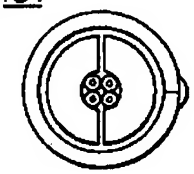
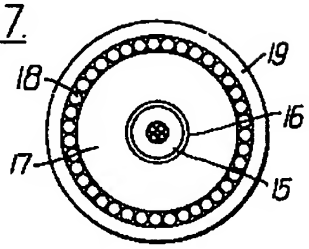


Fig.7.



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Sheet 2

Fig.8.